CLAIMS

What is claimed is:

1. A wireless sensor system, comprising:

a reader apparatus configured to generate an induction field;

a sensor apparatus configured to monitor structural integrity of an object, the sensor apparatus being communicatively linked to the reader apparatus and in a passive state until energized by the reader apparatus, the sensor apparatus including:

processing circuitry;

a resonant antenna configured to communicate data between the sensor apparatus and the reader apparatus, the resonant antenna being configured to collect energy from the induction field to energize the sensor apparatus;

a plurality of sensors, the sensors being respectively configured to measure predetermined parameters of the object, and to be independently interrogated by the reader apparatus, measurements obtained by the individual sensors being transmitted via a response signal in a return induction field, generated by the sensor apparatus, to the reader apparatus via the resonant antenna, the response signal being superimposed on the return induction field;

charging circuitry configured to store energy collected from the induction field to provide power to the sensor apparatus, the charging circuitry being configured to accumulate energy while measurements are being made by the plurality of sensors; and

the reader apparatus including:

a transceiver configured to communicate with the sensor apparatus;

an antenna having an induction loop;

a communications interface configured to be coupled to the antenna; and

a microprocessor configured to control operations of the reader apparatus, the reader apparatus being configured as a user-interface to the sensor apparatus, and the individual sensors of the sensor apparatus being independently interrogated by the microprocessor.

2. The system of claim 1, wherein the reader apparatus is stationary.

3. The system of claim 1, wherein the reader apparatus is mobile.

4. The system of claim 1, wherein upon storing predetermined energy in the charging circuitry, the processing circuitry of the sensor apparatus is configured to activate the sensor apparatus from a sleep state to an active state to perform a series of preprogrammed measurement steps to determine the structural integrity of the object, and wherein the antenna of the reader apparatus is configured to be tuned in order to match the resonant frequency of the antenna with a frequency of the object embedding the sensor apparatus.

5. The system of claim 4, wherein upon activation, individual ones of the sensors are polled to provide a response to the reader apparatus with measurement data obtained by the respective individual sensors.

6. The system of claim 4, wherein the sensor apparatus reverts back to the sleep state upon transmitting data obtained during the measurement steps.

7. The system of claim 6, wherein upon reverting back to the sleep state, the charging circuitry of the sensor apparatus is configured to accumulate energy to perform a subsequent cycle of measurements.

8. The system of claim 1, wherein the sensor apparatus communicates via short range telemetry in the frequency range of about 125 kHz to 134 kHz.

9. The system of claim 1, wherein the charging circuitry comprises a capacitor bank including a plurality of energy storage capacitors.

10. The system of claim 1, wherein the charging circuitry comprises a plurality of capacitor banks, individual capacitor banks including a plurality of energy storage capacitors.

11. A wireless sensor system, comprising:

a passive sensor apparatus configured to be embedded within a concrete structure to monitor infiltration of contaminants into the structure, the sensor apparatus including charging circuitry and a plurality of sensors respectively configured to measure environmental parameters of the structure including information related to the infiltration of contaminants into the structure; and

a reader apparatus communicatively coupled to the sensor apparatus, the reader apparatus being configured to provide power to the charging circuitry during communications with the sensor apparatus, the reader apparatus being configured to independently interrogate individual ones of the sensors to obtain information measured by the individual sensors, and the reader apparatus being configured to generate an induction field to energize the sensor apparatus, and information measured by the sensor apparatus is transmitted to the reader apparatus via a response signal that is superimposed on a return induction field generated by the sensor apparatus.

12. The system of claim 11, the sensor apparatus comprising:

processing circuitry; and

a resonant antenna having tuning circuitry configured to communicate data between the sensor apparatus and the reader apparatus, the charging circuitry being configured to store energy generated by the induction field, and the sensor apparatus being configured to be in an inactive state until energized by the induction field of the reader apparatus, and data obtained by the individual sensors being transmitted in the return induction field to the reader apparatus via the resonant antenna.

13. The system of claim 12, the reader apparatus comprising:

a transceiver configured to communicate with the sensor apparatus;

an antenna having an induction loop;

a communications interface configured to communicate information from a remote user to the reader apparatus; and

a microprocessor configured to control operations of the reader apparatus, wherein the reader is configured as a user-interface to the sensor apparatus.

14. The system of claim 12, wherein the charging circuitry comprises a plurality of energy storage capacitor banks, and wherein the antenna of the reader apparatus is configured to be tuned in order to match the resonant frequency of the antenna with a frequency of the object embedding the sensor apparatus.

15. The system of claim 14, wherein individual ones of the plurality of energy storage capacitor banks comprise one or more capacitors, wherein a first capacitor bank is configured to provide power to short-term sensor measurements, wherein a second capacitor bank is configured to provide power to enable continuous and extended operations of the sensor apparatus, and wherein the processing circuitry is configured to control operations of the plurality of capacitor banks.

16. The system of claim 14, wherein upon storing predetermined energy in the charging circuitry, the processing circuitry is configured to switch the sensor apparatus

from the inactive state to an active state to perform a series of preprogrammed measurement steps to determine structural integrity of the concrete structure.

17. The system of claim 16, wherein the sensor apparatus is configured to revert to the inactive state upon transmitting data that is obtained during the measurement steps to the reader apparatus.

18. The system of claim 17, wherein upon reverting back to the inactive state, the charging circuitry of the sensor apparatus is configured to accumulate energy for a subsequent cycle of operation of the sensor apparatus.

19. The system of claim 17, wherein the charging circuitry of the sensor apparatus is configured to accumulate energy at least while measurements are made by the sensors.

20. The system of claim 11, wherein the sensor apparatus communicates with the reader apparatus via short range telemetry in the frequency range of about 125 kHz to 134 kHz.

21. The system of claim 11, wherein upon activation by the reader apparatus, the sensor apparatus is configured to poll the sensors and provide a response to the reader apparatus with information measured by the sensors via the response signal.

22. A method of monitoring a bridge structure, comprising:

embedding a passive sensor apparatus within the bridge structure;

communicatively coupling a reader apparatus, disposed external of the bridge structure, to the sensor apparatus to enable data communication therebetween;

configuring the reader apparatus to communicate with the sensor apparatus via short range telemetry communication;

energizing the sensor apparatus via an induction field generated by the reader apparatus, the sensor apparatus being in an inactive state until energized by the reader apparatus, the energizing including storing energy generated by the induction field in a charging circuitry of the sensor apparatus, the charging circuitry configured to accumulate energy after the sensor apparatus reverts to an inactive state from an active state, and accumulate energy during measurement periods by the individual sensors;

performing measurements by the sensor apparatus after receiving an indication from the reader apparatus, or upon receiving an indication from a processing circuitry of the sensor apparatus that the charging circuitry is sufficiently charged to perform the measurements; and

transmitting the measurements to the reader apparatus via a response signal superimposed on a return induction field that is generated by the sensor apparatus.

23. The method of claim 22, wherein the charging circuitry comprises a capacitor, the method further comprising storing energy generated by the induction field in the capacitor.

24. The method of claim 22, wherein the performing comprises:

activating the sensor apparatus upon receiving the indication from the reader apparatus or the processing circuitry of the sensor apparatus;

polling individual sensors of the sensor apparatus subsequent to the activating; and

measuring predetermined parameters of the concrete structure using the respective individual sensors, wherein the performing is controlled by the processing circuitry configured to switch the sensor apparatus to the active state from the inactive state upon receiving an indication of the energizing of the charging circuitry to a predetermined charge level.

25. The method of claim 24, further comprising causing the sensor apparatus to revert to the inactive state upon transmission of data of the predetermined parameters to the reader apparatus.

26. The method of claim 22, wherein the transmitting comprises transmitting measurements obtained by the individual sensors in the return induction field to the reader apparatus via a resonant antenna.

27. The method of claim 22, wherein the communicatively coupling comprises coupling the sensor apparatus to the reader apparatus via short range telemetry in the frequency range of about 125 kHz to 134 kHz.

28. A method of monitoring structural integrity of a structure, comprising:

embedding a passive wireless sensor platform apparatus within the structure to monitor infiltration of contaminant materials into the structure;

communicatively coupling a reader apparatus to the sensor apparatus;

configuring the reader apparatus to communicate with the sensor apparatus via short range telemetry communication;

energizing the sensor apparatus via an induction field generated by the reader apparatus, wherein the sensor apparatus is in a passive state until energized by the reader apparatus;

monitoring the infiltration and obtaining corresponding measurements upon receiving an indication for the monitoring from one of the reader apparatus, or a processing circuitry of the sensor apparatus; and

transmitting the measurements to the reader apparatus in a response signal superimposed on an induction field generated by the sensor apparatus.

29. The method of claim 28, wherein the energizing comprises storing energy generated by the induction field in a charging circuitry including one or more energy storage capacitor banks.

30. The method of claim 28, wherein the monitoring comprises:

activating the sensor apparatus upon receiving the indication;

polling individual sensors of the sensor apparatus subsequent to the activating; and

measuring predetermined parameters of the structure using the respective individual sensors, wherein the monitoring is controlled by the processing circuitry configured to switch the sensor apparatus to an active state from an inactive state after receiving an indication of predetermined energizing of a charging circuitry of the sensor apparatus.

31. The method of claim 30, further comprising:

causing the sensor apparatus to revert to an inactive state upon transmitting the measurements to the reader apparatus.

32. The method of claim 30, further comprising:

accumulating energy in the charging circuitry during measurement periods by the individual sensors.

33. The method of claim 32, further comprising:

accumulating energy, in the charging circuitry, for a subsequent cycle of operation after the sensor apparatus reverts to the inactive state.

34. The method of claim 28, wherein the transmitting comprises transmitting measurements obtained by the individual sensors via the return induction field to the reader apparatus via a resonant antenna.

35. The method of claim 28, wherein the short range telemetry comprises frequencies in the range of about 125 kHz to 134 kHz.